Improvement of Manufacturing Quality
Burapha Wood Company in Laos

Khamtan Phonetip
Zahra Rashidian
Improvement of Manufacturing Quality

Khamtan Phonetip, e-mail: khamtanfof@gmail.com
Zahra Rashidian, e-mail: sr2007gol@yahoo.com

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Subject Category: Technology

University College of Borås
School of Engineering
SE-501 90 BORÅS
Telephone +46 033 435 4640

Examiner: Roy Andersson
Supervisor, name: Sara Lorén
Supervisor, address: Högskolan i Borås
SE-501 90, Borås
Client: Högskolan i Borås, Borås
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Abstract

Improvement of Manufacturing Quality Burapha Wood Company in Laos. The main office is located in Senoudom, Xaythany district, Vientiane Capital. (46 Kaysone Phomvihane Road, Ban Phonesaath, Vientiane).

This report is an initially study of the whole processes in the manufacturing aims to capture the current problems into groups of categories and prioritize the problem solving according to the frequency of the defects detection, the root causes are indentified and assessment of FMEA on the problems occurrence.

Research method is performed by interviewing the key persons who are representatives from the units, then use tools of quality improvement to analyze each step (Affinity, Pareto, Ishikawa and FMEA).

Conclusion of the study found that Burapha Wood Company is currently facing with three categories of problem, those are Machinery, Competency, Timber Drying and others with the list of problem are consisted.

The Two sided planer machine is a first prior to be undertaken of solution. Where the root causes are ignorance of workers not follow the machine’s instruction in such of reset the machine before operating and the record form has not filled when problems occurrence.

The processes where the company has to focus is on the Two sided planer machine which is a highest prioritized by pareto diagram based on FMEA analysis, but considering with the potential and possibility of solution Burapha Wood Company must intend on timber drying.

These problems are partial platform of improvement of manufacturing quality to get a COC certification.

Keywords: Problems categories, problems prioritization, processes risk
### Abbreviation

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACIAR</td>
<td>Australian Centre for International Agricultural Research</td>
</tr>
<tr>
<td>BAFCO</td>
<td>Burapha Agroforestry Company</td>
</tr>
<tr>
<td>COC</td>
<td>Chain of Custody</td>
</tr>
<tr>
<td>FMEA</td>
<td>Failure Mode and Effect Analysis</td>
</tr>
<tr>
<td>FSC</td>
<td>Forest Stewardship Council</td>
</tr>
<tr>
<td>Hr</td>
<td>Hour</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>Lao People’s Democratic Republic</td>
</tr>
<tr>
<td>MIC</td>
<td>Ministry of Industry and Commerce</td>
</tr>
<tr>
<td>QI</td>
<td>Quality Improvement</td>
</tr>
<tr>
<td>SE</td>
<td>South East</td>
</tr>
<tr>
<td>TFT</td>
<td>Tropical Forest Trust</td>
</tr>
<tr>
<td>RPN</td>
<td>Risk Prioritization Number</td>
</tr>
<tr>
<td>VALTIP</td>
<td>Value-adding to Lao PDR Plantation timber Products</td>
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1. Introduction

1.1 Background

Burapha Agroforestry the main office is located in Senoudom, Xaythany district, Vientiane Capital. (46 Kaysone Phomvihane Road, Ban Phonesaath, Vientiane, Lao PDR).

Vientiane is the name of the Capital City of Lao PDR, where The Lao People’s Democratic Republic is located in the center of Indochina, sharing borders with China to the north, Myanmar to northwest, Thailand to the west, Cambodia to the south, and Vietnam to the east. With a total area of 236,800 square kilometers with the population from survey fiscal year of 2007-2008 is 5.9 million (Laos, 2010).

The Burapha Group is a subsidiary of the Swedish forest industry company Silvi Nova AB, see available at http://www.silvinova.se/silvinova/pages/company_pres.htm (Nova). The company is producing and exporting wood products from its own plantations, with the main aim of showing that eucalyptus plantations can also be a renewable source of wood for high-quality wood products. The company believes that in the long term this could ease pressure on Asia’s natural forests. The company is involved in the Government Assessment Program and has been already assessed with excellent results. The Burapha is one of 15 companies which successfully passed the assessment requirements and criteria. Burapha Company appears capable of types 1-3 operations (Type 1, primary wood {log} processing, Type 2, secondary processing for veneer, panels and joinery stock, Type 3, secondary processing for furniture and wood stuff) and industry level 2 (51 to 200 people and medium environmental impact). The factory is located fifty minutes by car from Vientiane in a rural setting. The factory is a large open structure with concrete floors and corrugated iron roof. The factory houses a working sawmill, kilns and wood processing and assembly facility (Barbara Ozarska, 2007).

The complex is established at Nabong Farm, 30 km outside the Lao capital Vientiane and was commissioned in September 2000. The sawmill has an installed annual capacity of 20,000 cubic meters of logs, and the factory an annual capacity of 4000 cubic meters of readymade products. The establishment of this processing plant became a major step forward for the wood industry in the Lao PDR, and indeed the SE Asian region. It is a leading example of how, through foresight and innovation, beautiful hardwoods can be brought to discerning world markets without devastating the natural tropical forests. Plantation wood is transformed into affordable designer items much sought after in fashion and environmentally conscious households all over the world. Clean and environmentally sound production technology imported from Europe ensures BAFCO products meet the strictest world standards (BAFCO, 2009).
1.2 Problem statement

Every manufacturing or business running comprised of several activities in a system, but the problems always occurring more or less in realization. In order to continue improvement for manufacturing always need to explore the current situation of company which is a crucial activity to measure their performance by assessment the achievement during the period of a year or a sequence of time then solving techniques are applied the analysis based on factual data and information.

In general comment on priorities for this company development from the ACIAR project is highly needed on training in design, production management to improve efficiency, product quality and marketing, but they don’t have expertise in wood processing and manufacturing (Barbara Ozarska, 2007).

Burapha also has become as one of the member of Tropical Forest Trust (TFT) (Trust, 2007). And also a member of Chain of Custody and Occupational Health & Safety (COC) but have not yet certified (Chaikhieo, 2008). Currently the company is under the progress of internal audit for COC certification. Therefore, this study is very crucial to improve its capability to fulfill the international standard needed.

FSC chain of custody (COC) allows credible tracking of FSC material from the forest, through all successive stages of the production process, to committed retailer and consumers. COC certification is for operations that manufacture, process or trade in timber or non-timber forest products (FSC, 2011). Hence, the company has to be ensured that all their process units are meet the requirements and then they also need to know what current problem need to be solved soon.

1.3 Objective of study

In order to get a COC certification and improvement of manufacturing this report is an initially study of the whole processes in the manufacturing to capture the current problems into groups of categories and prioritize the problem solving according to the frequency of the defects detection, the root causes are indentified and assessment of FMEA on the problems occurrence.

2. Theoretical frame of reference

2.1 Data collection

One of the most important steps in programme for quality improvement, having a substantial basis for decision-making is vital. It is, of course, also essential that the basis elucidates the topic in question. In the ease illustrated it can be observed that the manufacturing process result in a large number of units with dimensions outside the upper tolerance limit (Bo Bergman, 2010). This type of check sheet is also called a frequency table as the Table 1: Check sheet of defects collected from Burapha Wood Company, in section 4.4.
2.2 Affinity Diagram

According to the Memory Jogger Plus entitle “Featuring the seven Management and Planning Tools” by Michael Brassard the Affinity is defined as “This tool gathers large amounts of language data (idea, opinions, issues, etc.) and organizes it into groupings based on the natural relationship between each item. It is largely a creative rather than a logical process”. Use Affinity in situation in which facts or thoughts are in chaos. When issues seem too large or complex to grasp, try an affinity to map the geography of the issue. Breakthrough in traditional concepts is needed. When the only solutions are old solutions, try an affinity to expand the team’s thinking. Support for solution is essential for successful implementation. The typical use of an Affinity diagram is in variety of organization in such of automotive supplier of electronics, Computer Company, manufacturing and automotive company. Therefore, it is suitable to use in wood processing manufacturer (Brassard, 1989). See the affinity diagram as Figure 10: The current problems detected in the manufacturing of Burapha Company, in section 4.3.

2.3 Pareto Diagram

There are several problems present in connection with a programme for quality improvements. In general only one problem can be solved at a time.

In pareto chart, each type of defects is illustrated by a rectangle whose height equals the number of defectives on the left-hand scale. The order between the different types of defects is such that the one with the largest frequency is placed furthest to the left. After that the number of defectives decreases to the right. The smallest columns furthest to the right can possibly be put together in one group “others”, if each one of them contributes too little. A line illustrating the cumulative number of defectives or the accumulated percentage of defectives is often drawn. However, this line does not appear in all pareto charts and its value can be discussed. It is important always to state where and when data has been collected. With the help of the pareto chart the most serious problem is very clearly made visible. When the problem is solved we can move on to the next. In this way each problem is focused on, one at a time (Bo Bergman, 2010). See the right-hand scale in Figure 11: Problem Solving Prioritization, in section 4.4.

2.4 Ishikawa Diagram

Ishikawa diagram or cause-and-effect diagram is a systematic analysis can be made which also called a fishbone diagram. This type of diagram was introduced for the first time by Dr. Kaoru Ishikawa in 1943 in connection with a quality improvement programme at the Kawasaki Steel Works in Japan. It’s construction rambles a simplified fault tree. In the diagram we first roughly describe those types of causes that can possibly produce the observe quality problem. Then we concentrate on one of these roughly described causes and try to investigate it in more detail. Cause and effect diagrams are usually developed by a team using post it notes during a brainstorming session. Often, the causes are then grouped into “major” causes which are structured one by one to get a result. Sometimes, however, the diagram also is developed “top-down”, ie. The work starts with identification of the “major” causes and then the causes of these are identified (Bo Bergman, 2010). In such, of figure 14 in section 4.5.
Potential failure mode and effects analysis in manufacturing and assembly processes (Process FMEA). Is an analytical technique used by a manufacturing/assembly-responsible Engineer/Team as a means to ensure that, to extent possible, potential failure mode and their associated causes/mechanisms have been considered and addressed. In this most rigorous form, an FMEA is a summary of the team’s thoughts (including an analysis of items that could go wrong based on experience) as a process is developed. This systematic approach parallels and formalizes that mental discipline that an engineer normally goes through in any manufacturing planning process. The FMEA identifies the process functions and requirements, identifies the potential products and process-related failure modes, assesses the effects of the potential failures on the customer, identifies the potential manufacturing or assembly process causes and identifies process variables on which to focus controls for occurrence reduction or detection of the failure condition, develops a ranked list of potential failure modes, thus establishing a priority system for preventive/corrective action considerations and documents the results of the manufacturing or assembly process. During the initial development of the process FMEA, the responsible engineer is expected to directly and actively involve representatives from all affected areas. These areas should include but are not limited to design, assembly, manufacturing, materials, quality, service, and suppliers, as well as the area nr a catalyst to stimulate the interchange of ideas between the areas affected and thus promote a team approach (William D. Carlson, 2001). See the FMEA as Table 5: Potential Failure Mode and Effects Analysis, in section 4.6.

3. Research Methods

This research method is divided into two parts of progress; the first step is performed by interviewing the key persons who are representatives from the units of production in manufacturing follow the questionnaires and check sheets. The study is together developing the question after the first interview to see and summary of the problems categories then the defectives data collection is conducted later in order to see which item of categories are supported information and available, but those we use tools of quality improvement to analyze each steps as the second part, each part are obvious described as following:

3.1 Interview

The information is collected by interview from different part of unit in the factory to see there are different part of problem occurred from units operation in such of;

- Production Manager: the manager is asked in whole area of the manufacturing based on his point of view. Especially, in safety care, competence, maintenance, management issues, products design, delivery, recruitment, timber storage and raw materials.

- Wood working Machines units: a key person was selected in order of asking the situation of carried out his responsibility with wood working machinery the question focused in and related to typical machines how the maintenance performed and
solving techniques in particular band saw, rip saw, sanding, planning planer, circular saw, carving, drilling the machines use in the manufacturing.

- Wood drying: a key person of wood drying process is asked how or what the current problem that he is facing and what is the technical solving in air drying, kiln drying, stacking timber, drying process, dryer system.

- Timber storage: a part of interview is carried out with observation to capture characteristic of the process and take an interview as personal view of the difficulty and to improve the existing problem that he/she is facing.

- Finishing: in this unit is focused in Packing, spraying, sanding. But the information needs are the defects and cost of improvement in this area.

- Shipment/products delivery: to indicate the current problems and complaint by the customers in products defectives, documentation and time consume.

The questions are extracted into the interview form for each unit. Empirical work is conducted in order to get information following the interview form created.

3.2 Application of tools

**Affinity diagram**: The problems found in the manufacturing are picked up from the interviews of all units, the problem items are categorized based on natural relationship into groups of problems.

**Pareto diagram**: all available frequency of defects detection from check sheet are filled into the table of excel sheet then use the QI Macro Program runs the result of prioritization of problem solving for the frequency of defects occurring.

**Ishikawa/Fish born diagram**: The necessary problem from prioritizing are continued in order to identify the root causes of the problem by Ishikawa diagram.

**Failure Mode and Effect Analysis (FMEA)**: In order to prioritize the level of serious risk of problem which should be started as the first point of solving, this kind of process based on the FMEA manner according to the failure mode of processes in the manufacturing.
4. Result of the study

4.1 The environment of the manufacturing

The company’s processing plant consists of a sawmill and a combined lamination plant and the company’s sawmill is specially designed to handle small diameter, low quality plantation logs. Sawing process, machinery and the whole production line is well planned, which allows the maximization of production efficiency and timer recovery (Figure 1).

![Figure 1: The working environment (Burapha Company)](image)

4.2 The working flow of the production line in the manufacturing

According to the observation the manufacturer’s working flow of product process consists of nine main steps (Figure 2) regarding to the arrow pointed to each other is come up from the logs which is the input raw materials to sawmill, this sawmill stage produces a piece of lumber/board and generates waste wood/wood stuffs, the piece of timber will be collected by worker in order to stacking and racking timber this are used a shift tailor move to air drying process, after several days of air drying those timber will be loaded into kiln dryer under computer controller to get a destination percent of moisture content (MC) in number of days according to the timber’s dimension and its species. Alternatively, the aim of drying is to avoid the timber crack, distortion, twice, collapse and getting desired percent of moisture content, after that the dried timber with its specific need MC is reached, then they are sending to machinery which following the design of products to the typical machines needed. In this process, the machines generates minor of wood stuffs where the wood off cut from the lumber/board dimension to make it fit to its products structure and components, but those wood stuffs are from sawmill and machines, waste wood used as fuel for steam boiler of kiln dryer. Products assembly is continued from the machinery task then after assembly, the products will be sent to finishing unit for sanding, color and spraying, then packing is a final step for the production line.
4.2.1 Sawmill

Sawmill is a timber converting process in the manufacturing for wood products processing when timber is ready stores in the factory, they are loaded into the saw for converting lumber or timber squares. Burapha Company sawmill unit has a machine controller, saw, worker on preparing timber into the saw operating, workers who sorting lumber and racking lumber, (Figure 3) shows how the work flow on this process.
4.2.2  Timber racking

A rack is a unit of timber where each row of boards is separated and spaced for drying with rack sticks. Correctly assembling the rack is vital to successfully drying, as the rack is the basic element handled through all the remaining stages of drying. The shape and arrangement of the rack influences: The restraint of individual boards, the consistency and quantity of airflow between the rows of timber, the effectiveness of air drying; and The quality and efficiency of controlled drying in predryers and kilns (Gregory Nolan, 2003a).

After the timber converted into boards, those boards are graded and sorted into proper with stick racking for drying process (Figure 4) shows how the lumber stick racking looks like.

![Figure 4: Timber racking](image)

4.2.3  Air drying (timber drying by air)

Activity during air drying: is to dry timber in racks in natural conditions to moisture content suitable for further processing with minimal inappropriate degrade. Air drying is the process of placing stacks of racked timber in the prevailing natural conditions so that they dry evenly to suitable moisture content. While uncontrolled, natural conditions experienced by racks can be moderated by: the orientation and placement of racks in the open, the use of buildings and other major elements as buffers from the sun and wind in the racking yard, the use of local environmental protections, such as hessian or shade cloth, over or around the racks; and by placing the racks in buildings or shelters. Air drying works because air moving through the gaps between the racked timbers dries moisture from the surfaces of the board. As it does so, moisture is drawn from the interior of the board to the surfaces where, in time, it also dries. This can be relatively quick until the timber reaches fiber saturation point, depending on the thickness of the timber, and its diffusivity. Beyond fiber saturation point, drying becomes progressively slower but will continue until the moisture content in the timber is in equilibrium with the prevailing natural conditions. During this process, the weight of other timber in the stack restrains each board and limits deformation (Gregory Nolan, 2003b).
When the racking timber is finished, they are moved to the storage where air dry is performing. Air drying lumber means timber or lumber are stored at the exposure place (Figure 5) only roof is constructed for the storage.

![Figure 5: Air dry process](image)

4.2.4 Kiln dryer

In kiln drying, lumber is placed in a chamber where airflow, temperature, and humidity are controlled to provide as rapid drying as can be tolerated by the lumber without increasing defects. There are several types of kilns. The different types are defined by the manner in which the temperature and humidity are controlled. The three most common types of kilns are Conventional, Dehumidification, and Solar (System, 2006).

Burpha company’s kiln named conventional kiln, it is preferred the heater by steam boiler which used waste wood as a fuel to generate the heat for kiln chamber, (Figure 6) shows the steam boiler and kiln dryer characteristic.

![Figure 6: Boiler left and Kiln right-hand side](image)
4.2.5 Wood stuffs

In the production line of manufacturing it is unavoidable to produce without waste, here in the wood processing area wood waste or wood stuffs is the wood off cut from the timber where they are unusable to produce their desired products, but they used as a fuel for steam boiler of kiln dryer to dry the timber. These wood stuffs are generated from when the logs are loaded into the sawmilling in steps of debarking, squaring timber, ripping, cutting, surface planer and others, (Figure 7) shows as wood waste from factory.

Figure 7: Wood stuffs from sawmilling and cutting machine

4.2.6 Wood Working Machinery

The company has well selected production machinery in the factory, with well designed factory layout and efficient work practices. It is evident that the company has highly experienced and skilled technical staff with a sound understanding of efficient production planning. The company processes logs into boards in a fully functioning automatic sawmill. Logs are processed through a series of breaking down saws, twin saws and smaller bench saws to a variety of finished sizes. These timbers are sticked out in packs and kiln dried. Secondary processing equipment includes four sided planers, double ended tenoning machines, spindle-moulders, a variety of drilling equipment and others were used in the production activity.

4.2.7 Products assembly

In reality of the assembly line of Burapha company is absolutely flowing as well. Products assembly is a unit of combining wood into its products design and following the template provided (Figure 8) demonstrates the activity of assembly.
4.2.8 Finishing

Surface preparation is the first step in the finishing process. Generally after planning, the wood surface will need some degree of preparation prior to finishing. Sandpaper, steel wool, or various finishing pads are commonly used to smooth and clean the surface to eliminate roughness and other defects that might influence the quality of the finish. Many types of material are used to manufacture sandpaper. Silicon carbide, ceramic, and garnet are the minerals most commonly used. Cloth, paper, or a combination of different films is used for the backing layer of the sandpaper. A typical furniture finishing process includes the following stages: sanding, bleaching, filling, staining, sealing, washcoat, glazing, topcoat, rubbing and others, depending on the type of finish desired, some of these steps may be eliminated, or other finishing processes may be added (Hiziroglu).

In reality of Burapha company, the finishing unit included only sanding and colors. But some products do not need to color this depending on customer need and preferable by customers. For sanding, mostly is performed by hand-sandpaper after assembly practice.

4.2.9 Packing production

When completed sanding and coloring products the final production is follow up by checking the products to ensure that there are no defects before shipping. As (Figure 9) the products are packed and covered by paper to avoid damage.
### 4.3 The current problem categories

The problems found in the company are occurred as a sequence of a year, a survey from early of January to April 2011. All problems are categorized into affinity diagram (Figure 10) which the information is collected from the survey by interviewing in different units of manufacturing included production manager. There are three main problems with one other of categories which included different items. Those categories are Wood machinery, Competency, Timber Drying and Other. According to the survey and interview performance manner by this methodology it was absolutely accessible to all units.

<table>
<thead>
<tr>
<th>Problem categories</th>
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<tbody>
<tr>
<td>Wood Machinery</td>
</tr>
<tr>
<td>Competency</td>
</tr>
<tr>
<td>Timber Drying</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>- 4 sided planer</td>
</tr>
<tr>
<td>- Docking machine</td>
</tr>
<tr>
<td>- 2 sided planer</td>
</tr>
<tr>
<td>- Worker lack of competence</td>
</tr>
<tr>
<td>- Lack of training</td>
</tr>
<tr>
<td>- No schedule of drying for specific specie</td>
</tr>
<tr>
<td>- Timber cracked, distortion after drying kiln</td>
</tr>
<tr>
<td>- Inadequate fuel for kiln drying</td>
</tr>
<tr>
<td>- Customer complaint some defect detection</td>
</tr>
<tr>
<td>- Document process for export is too long to be issued</td>
</tr>
</tbody>
</table>

Figure 10: The current problems detected in the manufacturing of Burapha Company
4.3.1 Wood Working Machinery

Wood working machinery is a main factor in the manufacture to provide good operating and unique for its production. Regarding to the observing the reality performance and interview with the operator, controller and maintenance we are noticed that there are three machines which frequently found problems in particular machine are the Four sided planer Machine, Docking machine and Two sided machine. These machines are needed in daily operating for their productivity.

All machines are imported from Sweden and they have been operated since 1992 when the plant was established, but those machines are second hand condition. Now they seem like very old and improper running when operating it. They are provided a unit of maintenance in order to intend on mechanical frequently check its status as weekly. But the problem still occurred during the operating the machine. The failure mode is bearing ball-broken, machine stops working, it is increased by temperature very quickly, ended cutting machine (Docking machine) is improper square and splits are occurred.

4.3.2 Competency

Large proportion of worker are not certified their competence and those employees are local people mostly in production line unit, since they are lacked of education, alternatively is only few employees are qualified and proven by their competences in manager level, foreman and the mechanical supports.

According to the affinity diagram of problem categories (Figure 10) concludes that only few items listed but much importance where people is an essence of the organization to fulfill their responsibility, function and to follow up the rule of the company to enable the ability for the company’s benefit. It is important to avoid and decrease man error in the production activity. Therefore, training should be supported into each skill which needed to upgrade their expertise for better performance and nicely products outcome.

4.3.3 Timber Drying

Timber drying process is a vital part of the manufacturing to get a requirement of percent moisture content in wood, to minimize the damaged timber by minor or serious crack, twice, distortion and collapse. Timber drying is the end activity of preparing wood into production line for its high valuable products.

In reality of wood drying process of Burapha Company there are three items listed in this categories those problems are the company haven’t got a schedule for specific species to dry the timber most procedure of drying process is based on controller experience which occurs the uncertain output it may consume the time, this make it slower, minor and serious crack, twice and distortion are usually occurred. Moreover, sometime wood waste use as fuel are not enough this may cause some budget from the company to buy from other sources as recent
years, but currently they harvest from their own plantation where they can collect by select cutting, tinning and other wood stuff from plantation area.

4.3.4 Others problems

Only few defectives are complaint by the customer but mainly are the defects on products characteristic when they received which some of products contains as minor crack on the surface wood, knots, twice and distortion where caused by drying process.

In the documentation for export the products is procedure that consume much time this cause by the system of the government rule. For instance, the customer orders the products in limited time, but the company has to document with its principle of two steps with different department concern regarding to the dispatch letter issued on 4th February 2008 by Ministry of Industry and Commerce No. 0157/MOIC, entitle “the controlling and transferring timber, forest product in domestic and for export” (MOIC, 2008). The department of industry will be followed up from log field to the manufacturers and to exports the products but the process of cutting tree and transfer from plantation to the log field is responsible for Department of Forestry.

By this process, the company has to follow up the rule and spend more time with the documentation in order to fulfill the requirement of organization concern. Therefore, this activities are waste the time and versus with the customer needs.

4.4 The problems solving prioritization

In the production process of Burapha Company mainly produce floor tiles, indoor and outdoor furniture (Burapha, 2009). The process is in the manufacturing consists of sawmill, drying wood, cutting, assembly those are through machinery until packing products. Regarding to the interview with the check sheet the answer are fully provided by key person in specific area of processes which they could give a number of defects in their recent work as the (Table 1).

The mainly problem occurrences are on the wood working machines, drying process with inadequate fuel for steam boiler and other is Customer compliant and inadequate fuel for drying timber.
Table 1: Check sheet of defects collected from Burapha Wood Company

<table>
<thead>
<tr>
<th>No</th>
<th>Processes</th>
<th>Problem</th>
<th>No. defects</th>
<th>Percent of Defects</th>
<th>Cumulative percents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 sided planner</td>
<td>Wood stuck in machine and stops working</td>
<td>160</td>
<td>79.60</td>
<td>79.60</td>
</tr>
<tr>
<td>2</td>
<td>Docking</td>
<td>Shacking with not proper ended square</td>
<td>16</td>
<td>7.96</td>
<td>87.56</td>
</tr>
<tr>
<td>3</td>
<td>Timber Drying</td>
<td>Cracked/distortion</td>
<td>10</td>
<td>4.98</td>
<td>92.54</td>
</tr>
<tr>
<td>4</td>
<td>4 sided planner</td>
<td>Bearing ball broken</td>
<td>8</td>
<td>3.98</td>
<td>96.52</td>
</tr>
<tr>
<td>5</td>
<td>Others</td>
<td>Customer compliant and inadequate fuel for drying timber</td>
<td>7</td>
<td>3.48</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>201</td>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>

The following (Figure 11) is revealed by IQ macro Program inputted the data from check sheet visualizes called pareto diagram (one of the seven quality improvement tools) the problem prioritization based on the recently number of defects or frequency of defects detection in the processes. The first prioritized belong to Two sided Planner Machine which the defects is up to 160 times or 79.6% of occurrence in this year (2011) indicated from early of January to April, follow by another machine calls Docking machine, but seems that the defects detection number is very low in such of only 16 defects found, so we can say that there are just occasionally or minor defects with others, except Two sided Planner Machine.

![Problem Solving Prioritization](image)

Figure 11: Problem Solving Prioritization
4.4.1 Two sided Planner Machine

Two sided planer or double sided planer machine is used for wood processing plant. The heavy cast-iron machine frame structure is computer-designed to provide optimal vibration absorption, the precise plane surface processing with two spindles ensure the precision and long life of the machine.

The (Figure 12) demonstrates the current status of the machine installed in the manufacturing which being operated for products processes. It is the highest defects detection where the improvement must be focus on, this machine is frequently it stops working and hanging by timber or wood stuck, the high temperature (hot) is increased very quickly when it is operated in a sequence of time. This machine is needed always for their productivity to be continued operating. In facts, this machine could run properly but when it is used in function it is usual reoccur the problem.

This problem is identified by causes and effects diagram method to find the root causes as a component of the causes to the effect, see section 4.5.

![Figure 12: Two sided Planner Machine](image)

4.4.2 Docking machine

Docking is the cross cutting of a board to remove an undesirable characteristic, such as a split or a tapered end or to reduce the board to a more desirable length. As boards are cut from preferred length logs, they should only be cocked during sorting or tapered end board may jam in the feed line of machinery. Both should be docked (Gregory Nolan, 2003a).

This machine’s status looked like the status of the Two sided Planer Machine, both are very old and in secondhand condition both were imported from Sweden in 1992. The failure is
occurred with Docking machine as it could not prefer good result when the end-two sided of timber are cut which it should be squared, but it doesn’t. This problem may occur from the spare parts are old and it is improperly use. Regarding to the mechanical checked he mentioned that it is cause by the expanded belt but this kind of belt is not available in Laos so they must order from Sweden or original suppliers.

4.4.3 Timber Crack

Surface checked separation of fibers along the grain forming a fissure, but not extending through the piece from face to face. Checks commonly result from stresses built up during seasoning. They tend to run radially, across the growth rings. Internal checked- In timber, separation of the fibers in the interior of the piece, usually in the radial direction. The checks are often not visibility on the surfaces and may not be visible on a cut section. End checked failure, usually radial on the end of a log, timber, or board resulting from stresses caused by too rapid or excessive end drying. Change in the shape of a piece of timber due to drying or other sources of stress. Distortion may take the form of cup, bow, twist, spring or diamonding (Gregory Nolan, 2003b).

Since the Company lack of specific schedule for each species of tree when drying timber, mostly there are three species input as raw material into manufacturing named Acacia Mangium, Eucalyptus Camaldulensis and Tectona grandis. From their own plantation, only minors cracked on timber occurred after drying process; they use their own controllable experience in drying process. This could not be a serious problem because the company could solve the problem to elucidate the minor checks by gluing (Hot glue) when this glue is used those minor check will disappear with nicely.

However, the crack is not only one problem detected in this process either the twice or distortion on timber this may cause by incorrect on racking technique either schedule of drying process is incorrectly.

4.4.4 Four sided Planer Machine

This machine you can make sure any part will be produced precisely by four spindles (Figure 13). This machine is usually run and daily use, but the problems occurred quite few times it is only 3.98% of defects detection during early of a year. The failure mode is Bearing ball-broken but this problem could be solve and continue running machine while the bearing ball could be easily find out in the local market with cheap price and new bearing ball could be placed in an hour.
4.4.5 Others defective detection

In the wood drying process it must ensure that the company could provide fuel enough during the timber drying process. Sometimes happen in the company on inadequate fuel, thus they have to buy from other sources and from their own plantation. This can cause the delay products when the drying could not reach on time and some minor check and distortion occurred when the fuel is almost finished.

4.5 The Root Cause of Problems

Following the pareto diagram reveals the problem priority to be solved which we found that problem is named the frequently stop working when the wood stuck on the Two sided Planner Machine presents in (Figure 12), deriving from check sheet and pareto visualization, considering with brain storming from the employees, foreman and maintainer by interviewing we are able to conclude the main causes of effect are consisted of operator, Machine and controller/maintenance.

The machine looks like very old it was started to operate since the Company was established in 1992, but it was certainly a secondhand condition imported from Sweden, at the present this machine is continuing as daily use together with weekly maintenance activity which is provided as well in filling oil, fixing the spare parts to be proper use. Offering an advice to operators how to use the machine correctly, but the recording form of using has not been recorded neither operator’s ignorance.

According to the Ishikawa method we characterize the root causes of each main cause to present the problem’s root cause where the Company can elucidate and solve that problem. The two circles red marked in the figure 14, the symptoms that the actual root causes of the Two sided Planner Machine that frequently stops working are the Cutter head is not reset properly before operating machine and missing a checking record the use of machine.
4.5.1 Resetting machine

The first mark red circle refers to “the cutting head is not reset properly before operating the machine”. In the reality of products process in the manufacturing is quite complexity of activities and every machine needs to be reset before use to ensure the output is alignment with expectation, so that people always make something easy could be fail or error. For instance, the wood lumber has different size and dimension to load in, in this case the machine needs to be reset the cutting head such the blade to fit with its capable level, but the operators are careless about this, then the machine always stop/hanging, this mean the instruction of this machine is not in use.

4.5.2 Recording form

Recently the company has a recording form in use of specific type of machine but it work improperly while the observing can see that it is blank form and operator never fill into it after operating and or when the problem promptly occurred. The controller did enforce the rule as the instruction should be performed by the company as strictly to be more effectively. The controller must be report to the top management concerning the operating machine.

4.6 The risk prioritization

Following the problem categories, problem prioritization and root cause analysis above mentioned in each category explanation we can see that every process has different causes of failure mode in such of the process for Two sided Planer, Four sided Planer, Docking
Machine and Wood Drying process. These four types of failure mode are determined to analyze their FMEA (Table 5).

This is deeply study within process FMEA method where the information and verbal are from different people who concern and expertise in each process. For instance, of wood working machine the interview is undertaken with foreman, manager, operators, maintainer unit, mechanical technician and other sources of references relation.

More detail in each process consists of the explanation for potential failure mode, potential effect of failure, current process controls prevention and current process controls detection where they are measured by rating scale of severity, occurrence and detection which is an output of risk prioritization number (RPN= Severity*Occurrence*Detection). See (Table 2, Table 3 and Table 4) are the rating scale of severity, occurrence and detection.

**Table 2: Severity Rating Scale**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non</td>
<td>Adjustment or other process controls can be done during normal maintenance and no defective parts.</td>
</tr>
<tr>
<td>2</td>
<td>Very minor</td>
<td>Downtime of up to 30 min but no production of defective parts.</td>
</tr>
<tr>
<td>3</td>
<td>Minor</td>
<td>Downtime between 30 min to 1 hr, but no production of defective parts.</td>
</tr>
<tr>
<td>4</td>
<td>Moderate</td>
<td>Downtime between 1 to 4 hrs within production of defective parts.</td>
</tr>
<tr>
<td>5</td>
<td>Low</td>
<td>Downtime up to 1 day within production of defective parts.</td>
</tr>
<tr>
<td>6</td>
<td>High</td>
<td>Downtime between 1 day-5 days within production of defective parts.</td>
</tr>
<tr>
<td>7</td>
<td>Very high</td>
<td>Downtime between 1 -2 weeks within production of defective parts.</td>
</tr>
<tr>
<td>8</td>
<td>Warning</td>
<td>Downtime more than 2 weeks within production of defective parts.</td>
</tr>
</tbody>
</table>
Table 3: Occurrence Rating Scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>failure occurs survey in a month</td>
<td>1 failure occurrence in 2-4 weeks or 30 days</td>
</tr>
<tr>
<td>2</td>
<td>failure occurs survey in 2 weeks</td>
<td>1 failure occurrence between 1- 2 weeks</td>
</tr>
<tr>
<td>3</td>
<td>failure occurs survey a week</td>
<td>1 failure occurrence in a week</td>
</tr>
<tr>
<td>4</td>
<td>failure occurs survey in 3 days</td>
<td>1 failure occurrence between 1-3 days</td>
</tr>
<tr>
<td>5</td>
<td>failure occurs survey a day</td>
<td>1 failure occurrence between 4 - 8hrs</td>
</tr>
<tr>
<td>6</td>
<td>failure occurs survey in 4 hours</td>
<td>1 failure occurrence between 1-4 hrs</td>
</tr>
<tr>
<td>7</td>
<td>failure occurs survey an hour</td>
<td>1 failure occurrence between 30min- 1 hr</td>
</tr>
<tr>
<td>8</td>
<td>failure occurs survey minute</td>
<td>1 failure occurrence in 30 min</td>
</tr>
</tbody>
</table>

Table 4: Detection Rating Scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very high</td>
<td>Design controls almost certainly detect a potential cause and subsequent failure mode, machinery control not required.</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>Design controls may detect a potential cause &amp; subsequent failure mode. Machinery controls will prevent an imminent failure &amp; isolate the cause.</td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>Design controls may detect a potential cause &amp; subsequent failure mode. Machinery controls will provide an indicator of imminent failure.</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
<td>Design or Machinery controls do not prevent the failure from occurring. Machinery controls will isolate the cause &amp; subsequent failure mode after the failure has occurred</td>
</tr>
<tr>
<td>5</td>
<td>Very low</td>
<td>Design or Machinery controls cannot detect a potential cause &amp; subsequent failure, or there are no design or machinery controls</td>
</tr>
</tbody>
</table>
### Table 5: Potential Failure Mode and Effects Analysis

<table>
<thead>
<tr>
<th>Processes</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Severity</th>
<th>Potential Cause(s) / Mechanism(s) of Failure</th>
<th>Current Process Controls Prevention</th>
<th>Occurrence</th>
<th>Current Process Controls Detection</th>
<th>R. P. N.</th>
<th>Recommended Action(s)</th>
<th>Responsibility &amp; Target Completion</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two sided planner Machine</td>
<td>Wood stuck in the machine</td>
<td>Machine stops working, downtime, timber damaged and explosion may occur</td>
<td>2</td>
<td>Machine not reset properly before operating</td>
<td>Stop working up to 10 minutes then restart machine again</td>
<td>6</td>
<td>Reoccurrence</td>
<td>5</td>
<td>60</td>
<td>Formulate new rule and restrict enforcement to follow up operating the machine, organize training for specific use of machine with provide record form of using</td>
<td>Foreman, Manager and Mechanical, this can be finished in one week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard push on loading timber into machine</td>
<td></td>
<td>Give a notice to operator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Foreman and manager provide training and rule for all employees in a week</td>
<td>2</td>
</tr>
<tr>
<td>Docking machine</td>
<td>Curve, split</td>
<td>Gain waste from angle off cut/wood stuff and timber split or damaged</td>
<td>2</td>
<td>Vibration</td>
<td>Place on the ground of concrete</td>
<td>3</td>
<td>Reoccurrence</td>
<td>3</td>
<td>18</td>
<td>Maintenance weekly, order new belt from Sweden/original supplier</td>
<td>Manager or purchasing unit provide budget this could be issued in a week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expanded belt/old</td>
<td></td>
<td>Tight the belt immediately</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Contact to the original hardware supplier in Sweden in one month</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 5.1
Prepared by: Khamtan Phonetip and Zahra Rashidian
FMEA - Date: 28 April 2011
<table>
<thead>
<tr>
<th>Processes</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Severity</th>
<th>Potential Cause(s) / Mechanism(s) of Failure</th>
<th>Current Process Controls Prevention</th>
<th>Occurrence</th>
<th>R. P. N.</th>
<th>Recommended Action(s)</th>
<th>Responsibility &amp; Target Completion</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying Timber</td>
<td>Timber/lumber surface checked, ended crack and distortion</td>
<td>Downtime, Customer unreliable and unsatisfactory, low graded timber</td>
<td>6</td>
<td>No schedule drying for specific species</td>
<td>Reuse the method from experience in drying wood, wood cracked and minor check is solved by hot glue to elucidate the minor defect</td>
<td>1</td>
<td>3</td>
<td>18</td>
<td>Invest on experiment to develop wood drying schedule for each species this could be contact to the University or other expertise</td>
<td>Manager and drying unit with external experts in wood drying</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inadequate fuel</td>
<td>Buy fuel from other sources immediately, collect small wood in their own plantation by thinning and select cutting.</td>
<td>4</td>
<td>24</td>
<td></td>
<td>Estimate the existing fuel to ensure that it is enough before drying process.</td>
<td>Kiln dry controller this could done in a day</td>
</tr>
</tbody>
</table>

Table 5.2
Prepared by: Khamtan Phonetip and Zahra Rashidian
FMEA - Date: 28 April 2011
### Potential Failure Mode and Effects Analysis
(Procedure FMEA)

**Table 5.3**
Prepared by: Khamtan Phonetip and Zahra Rashidian
FMEA - Date: 28 April 2011

<table>
<thead>
<tr>
<th>Processes</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Severity</th>
<th>Potential Cause(s) / Mechanism(s) of Failure</th>
<th>Current Process Controls Prevention</th>
<th>Occurrence</th>
<th>Current Process Controls Detection</th>
<th>R. P. N.</th>
<th>Recommended Action(s)</th>
<th>Responsibility &amp; Target Completion</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four sided planner</td>
<td>Bearing ball broken</td>
<td>Downtime, lost money, accident and machine damaged</td>
<td>4</td>
<td>low quality and it does not match with the original one</td>
<td>Buy the bearing ball from local market</td>
<td>3</td>
<td>Every week as 2 times per week that the bearing ball broken</td>
<td>4</td>
<td>Order original bearing ball and buy them from origin manufacturer</td>
<td>Manager contact supplier company in abroad</td>
<td>Contact to the original hardware supplier in Sweden in one month</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Machine not reset properly before operating</td>
<td></td>
<td>Give a notice to operator</td>
<td></td>
<td>4</td>
<td>48</td>
<td></td>
<td>Formulate new rule and restrict enforcement to follow up the operating the machine, organize training for specific use of machine</td>
<td>Foreman, Manager and Electrician</td>
<td>Train how to use the machines and the maintenance this could be done in 1-2 days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action Results</th>
<th>Severity</th>
<th>Occurrence</th>
<th>Detection</th>
<th>R. P. N.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action Results</th>
<th>Severity</th>
<th>Occurrence</th>
<th>Detection</th>
<th>R. P. N.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

24
4.6.1 Ranked Prioritization Risks

According to the FMEA analysis (Table 5.1, table 5.2 and table 5.3) expose potential failure mode, potential effect, potential causes, current process control prevention, current process control detection, recommended action and the RPN of four processes. The first prior is belonged to the Two sided planer Machine (Figure 15) reveals the risks prioritization, so the Two sided planer machine is the first thing or process the company has to focus on and taking into account of solution. The RPN of the Two sided planer machine is up to 60 with 40.8% of accumulative, this is the number of RPN derived from designed scale of severity, occurrence and detection. Following by the Four sided planer Machine down to 48 with 73.5% of accumulative, Drying process is 21 and Docking Machine is 18 of RPN.

![Figure 15: Risks Prioritization](image)

4.6.2 Recommended action

Considering on the Two sided machine there are some of the recommended action provided in the table 5.1 mentioned that the company should formulate new rule and restrict enforcement to follow up operating the machine, organize training for specific use of machine with provide record form of using machines. This recommended is obviousness to fulfill the solution of two potential cause failures in such of Machine not reset properly before operating and hard push on loading timber into machine, based on the design scale to measure the level of risk the current RPN is at 60 or 40.8% of accumulative, where the current process control was provided, but the problem is reoccurrence. However, this failure mode could be solved by the company if they follow the recommended action provided as mentioned above.
Others process. In particular, shown in (Figure 15) consist of three processes such as the Four sided planer Machine, Drying timber and Docking Machine. These processes are provided recommendation based on each causes of failure modes under the responsibility of internal and external people who may concern. The external need is the investment on experiment to develop wood drying schedule for each species this could be contact to the University or other expertise who is in specific area, but the spare parts of machines must be contact with original supplier from Sweden or somewhere else’s available supplier of good quality spare parts of machines.

4.6.3 The potential result of the actions

The potential of the action could not be reached if the company is not follow up the responsibility neither action taken. This responsibility could be assigned to foreman, Manager and Mechanical, this can be finished in one week, foreman and manager provide training and rule for all employees in a week, this task is obviousness and possible in order to take action without any obstacle except the Drying timber process.

Regarding to the discussion with the group of concerning in their responsibility in manufacturing on those risks more proportion trend to be possible for solution. Only Drying timber process has to be careful and collaborate with a University or an expertise that can carry out the task of doing experiment to develop schedules for each tree species. This might be a crucial while this process is a cause of customer complaint on products defective.

Faculty of Forestry at NUOL is being gradually recognized as the centre of knowledge and innovation in the Wood Industry in Laos. This year, the Faculty’s WoodTech Laboratory was enriched by new high value equipment when an experimental timber drying kiln was purchased from the VALTIP project budget money. The kiln was designed and built in Vietnam, by the company “CAXE.ETE Co. Ltd”, which was selected for its kiln drying experience, high quality products and technical support offered at a competitive price (DAIAN, 2010).

Therefore, Burapha company should contact with external Universities or other laboratory outside the country, but this may take several days up to months or years, however this task can be collaborate with the Faculty of Forestry for its assistance.

4.6.4 Comparison of RPNs

The action result of recommended could be potential since the confidence from those key persons are measured by their unity of putting the level of design scale of severity, occurrence and detection, if comparing of the current process control of the risk prioritization number (RPN1) with recommended action result of risk prioritization number (RPN2) in (Table 6) we can see that the risks of the Two sided planer machine, Four sided planer machine and Docking machine could decrease from 77.78% to 96.67% of possibility of resolution. Otherwise, drying timber is a smallest percents; only 54.76 percent could decrease of possibility of resolution, this exposure of warning the company to intend on drying timber in order of taking the timber drying into account of emergency.
Table 6: Decreasing Risk by Percentage

<table>
<thead>
<tr>
<th>Process</th>
<th>RPN1</th>
<th>RPN2</th>
<th>Different</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two sided planer</td>
<td>60</td>
<td>2</td>
<td>58</td>
<td>96.67</td>
</tr>
<tr>
<td>Four sided planer</td>
<td>48</td>
<td>2</td>
<td>46</td>
<td>95.83</td>
</tr>
<tr>
<td>Drying timber</td>
<td>21</td>
<td>9.5</td>
<td>11.5</td>
<td>54.76</td>
</tr>
<tr>
<td>Docking machine</td>
<td>18</td>
<td>4</td>
<td>14</td>
<td>77.78</td>
</tr>
</tbody>
</table>

The graphical (Figure 16) reveals the trending of decreasing risks under the current process control symbole as (RPN1) and recommended action result is (RPN2). The red circle mark is warning to be intended and it should be followed by the recommended action provided in FMEA table. This is compared to each other on processes of Two sided planer, Four sided planer, Drying timber and Docking machine which given them by 100 percents of total.

![Figure 16: Percent of potential improvement](image-url)
5. Conclusions

Burapha Wood Company is currently facing with three categories of problem; those are Machinery, Competency, Timber Drying and others. The list of problems consisted of the wood stuck in 2 sided planer machine make it stops working, ended timber cut is not proper square when using Docking machine, bearing ball broken in 4 sided planer machine. Workers lacked of competence on their responsibilities, lack of training support. There is no schedule for timber drying which is a cause of products defect (crack and distortion) and customer complaint, fuel for drying process is inadequate.

The current problem with highest frequency of defect is the Two sided planer machine which is a first prior to be undertaken of solution. But this root causes come from ignorance of workers not follow the machine’s instruction in such of reset the machine before operating and the record form has not been filled when problems are occurred.

The processes where the company have to focus on the Two sided planer machine which is a highest prioritized by pareto diagram based on FMEA analysis, considering with the potential and possibility of solution Burapha Wood Company must intends on timber drying.

Therefore, these problems categories, problem prioritization, the root cause of the problem and the risk assessment based on problems found, these are partial platform of getting COC certification and continue improvement of manufacturing quality.
References


MIHAI DAIAN. 2010. VALTIP-project, the activities update. No.03.


HIZIROGLU, S. Practical Approaches to Wood Finishing, Oklahoma State University.


SYSTEM, N. 2006. Introduction to Kiln drying